India's brain drain to the US

R. R. Gulati

Since the early sixties there has been a continuous outflow of scientific and technical personnel from developing countries to the developed countries of the West especially USA. The developing countries have been deeply concerned over this 'reverse flow of technology' to the developed countries. This concern rises from the widespread feeling that the outflow while being beneficial to the developed countries and emigrants concerned, it represents a serious loss, both actual as also potential, to the less developed countries. Like other developed countries India has been experiencing a similar phenomenon which has been a matter of concern to the policy-makers, public and those concerned with the utilization and training of S&T personnel. In this context one has to distinguish between two types of outflows. A scientist or technologist who goes to the advanced countries for a post-graduate or a post-doctoral study and returns with additional qualifications will be highly valuable to his country. However, if he decides not to return to the country, his emigration becomes a retrograde step for his country's economic progress.

On account of complete lack of information on the number, academic background and utilization pattern of Indian scientists and technologists migrating to other countries for higher education, teaching, research, etc. it has not been possible to have a broad idea about the effect of this outflow on the economy of the country. Most of these personnel are however known to be concentrated in the US. It was, therefore, decided to carry out a study of the Indian scientists and technologists studying and working in USA under the auspices of the Indo-US Sub-Commission on Science and Technology. For this purpose the co-operation of the National Science Foundation, USA, was utilized to collect data from sources available with them. The present report is the outcome of this study and is an attempt to contribute a better base for evaluation in the limited area of specific focus. While the main emphasis of the report is on the Indian scientists and technologists, data in respect of other countries have extensively been quoted with a view to highlighting India's position *vis-a-vis* other developing and developed countries.

There has been a considerable amount of discussion regarding the factors that prompt people to migrate. There is almost near-unanimous view that labour market factors such as salary levels, job opportunities, higher living standards and the potential for saving accumulation are some of the pull factors which attract scientists and technologists to USA. At the same time, over the years, the country has moved towards a system which tends to deny the rewards of success and narrows the gap between the brilliant and the moderate, the successful and the unsuccessful ones. To this can be added the inadequate nature of research facilities at home which restricts the skilled manpower to exploit their potential to the fullest possible extent. To escape from this some people, endowed with the spirit of adventure, try to seek their future elsewhere.

US immigration laws

Changes in the US Immigration Laws and Regulations have a great bearing on the level and participation of foreign citizens in the US labour force. The Immigration and Nationality Act of 1952 as amended is the basis of the current US immigration policy. Immigration for permanent residence in the US is limited to 290,000 in any year with a maximum of 20,000 for any country. This act also provides for admission outside of these limitations. About 80% of the quota is reserved for persons related to US citizens or permanent resident immigrants. Other would-be-immigrants must compete for the remainder of the preference quotas on the basis of having occupational skills needed in the US because of insufficient supply of domestic workers. The Secretary of Labour, USA may have to certify that these immigrants will not adversely affect the wages or working conditions of similarly employed workers.

In addition to the permanent resident immigration, the Act also permits foreign citizens to be in that country to work for temporary periods. There are no quota limitations for such temporary visas. These are granted for one year extendable to persons in the professions with no certification required by the Department of Labour. Foreign students upon graduation may be granted up to one year of residence for work providing practical training. With some exceptions, scientists and engineers employed in the US on temporary visas are eligible to adjust status to permanent resident immigrants. In particular, former students after completion of their year of practical training may be eligible to adjust status to permanent residence or apply for other types of temporary visas thereby extending their stay in the US work force.

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Indian S&T personnel admitted in USA

In so far as the number of Indian scientists and technologists who migrate to USA is concerned, *the only source of data is the record maintained by Immigration and Naturalization Services of that country.* Table 1 presents data regarding Indian scientists, engineers and physicians admitted to US from India during 1966–86 with gaps for four intervening years. If one were to make an estimate for these gap years, the number of Indians admitted as immigrants in the US during 1985–86 would be roughly of the order of 45,000.

It may be noted from the table that there are wide fluctuations in the number of immigrant scientists, engineers and physicians. These, to a large extent, are influenced by the US immigration laws and the labour market situations in that country. In 1965, the US immigration laws were amended to abolish the strict quota limitations on the basis of national origin. The impact of this law was that the number of Asian immigrants increased with a corresponding growth in the number of Indian scientists and technologists. The peak was reached in 1971. The sharp decline in 1973 and subsequent movements through 1986 reflected changes in the regulations making immigration of persons seeking entry as professional and skilled workers dependent on labour market conditions.

Fifty-four per cent of the S&T personnel admitted as immigrants from 1966 to 1986 were engineers, 30% were physicians and surgeons, 14% were natural scientists and the rest 2% were computer specialists. The later category of S&T personnel were initially clubbed with natural scientists. During 1985 their number was almost 40% of the combined total of these two categories put together. Table 1 also shows that the number of persons admitted as physicians and surgeons, experienced a sudden fall in 1978. Their number in 1984 and 1985 is also less compared to the earlier years. This may perhaps be on account of the fact that certain restrictions have been put on the migration of Indian medical graduates going abroad for higher education and training. Simultaneously, attempts are being made to provide better working conditions to the medical doctors within the country.

At this stage it may be pertinent to draw attention to the fact that the total cumulative stock of S&T personnel in the country in 1985 was 3.3 million and the number who left the country for USA during 1966–85 was only 45,000. If one were to look at numbers alone, this 14% figure may not appear to be significant. However, taking into account the fact that most of these personnel are from the prestigious institutions in the country, their outflow may be considered as detrimental to the progress of the country.

According to the American laws those granted permanent immigrant status are eligible to adopt US citizenship after five years of their stay in the US. No data are however, available regarding the number of personnel who had/would have ultimately embraced US citizenship but it would not be incorrect to infer that the eligible persons would either have become US citizens or are still working in that country.

Distribution by age, sex and field of specialization

The distribution of immigrant Indian scientists and technologists admitted to USA by age, sex and field of

Table 1. Immigrant Indian scientists, engineers, physicians admitted to the US during 1966–86.

Year	Engineers	Natural scientists	Computer specialists	Physicians and surgeons	Total
1966	647	226	—	40	913
1967	1067	315	—	87	1469
1968	944	241	—	96	1281
1970	2361	439	—	242	3042
1971	3236	741	—	821	4798
1972	2515	702	—	1513	4730
1973	641	225	—	1630	2496
1974	669	227	48	1049	1993
1975	980	264	86	1357	2687
1976	900	274	82	1611	2869
1977	790	328	65	1567	2750
1978	1153	385	102	596	2236
1982	1059	259	137	—	1455
1983	1040	255	84	—	1379
1984	779	142	37	461	1419
1985	1310	236	145	486	2177
1986	1003	274	—	—	1277
Total	21,094	5,533	786	11,556	38,971

Table 2. Immigrant Indian scientists and engineers to USA by sex and age group for 1986.

	M	F	M	F	M	F	M	F	Total
	<30 years		30–45 years		45 and over		Total		
Scientists	82	20	122	21	25	4	229	45	271 (21)
Engineers	477	29	386	9	102	—	965	38	1003 (79)
Total	559	49	508	30	127	4	1194	83	1277 (100)

specialization during 1986 is given in Table 2. (Although this analysis is restricted to one year, it would be reasonable to assume that there would be no appreciable deviation if the entire data were analysed.)

About 37% of the scientists who migrated to USA were less than 30 years of age. In the case of engineers, about 50% of the immigrants to USA were less than 30 years. The overall figure being a little less than 50%. This shows that the current movement of S&T personnel is highly selective and concentrated on young engineers and technologists who are less than 30 years of age. This is a reflection of the rapid advancement in technology which makes a technologist with recent training more valuable. They are at the height of the mental career at the start of their most productive years. To this extent their departure from S&T scene of the country is highly undesirable in an economic sense and it retards the proper industrial development of the country.

Most of the Indian scientists and technologists settled in the US initially migrated as students. A study conducted by the National Science Foundation reveals that about 80% of the increase in the foreign origin scientists and engineers between 1972 and 1982 consisted of persons who were science and engineering students in USA. It would, therefore be desirable to study this aspect in a greater detail.

US policy in accepting students

The US Federal Policy on accepting foreign students in general hinges on three pieces of legislation, viz. (i) the US Information and Exchange Act of 1948—the purpose of which was to increase mutual understanding between the people of the US and those of other countries, (ii) the Mutual Education and Cultural Act of 1961—which provided for the Fullbright Scholarship Programme, and (iii) the Foreign Assistance Act of 1961—which established training programmes under the aegis of the Agency for International Development. Before focusing our attention on Indian students, it would be worthwhile to have some idea about the foreign students enrolment in US and its increase over the period of time.

Foreign students in USA

Although the number of foreign students increased ten-fold over the period 1955–85, their proportion depended on the level of total US enrolment.

Figure 1 shows that the number of foreign students has increased from 30,000 in 1955 to more than 300,000 in 1985 but foreign enrolment as a per cent of total enrolment changed from 1.4% in 1955 to 1.6% in 1975. Thereafter there has been a sharp increase inasmuch as foreign enrolment constituted 2.7% of total enrolment in 1985.

Foreign students by region of origin

There has been a sustained increase in the number of students from South- and East-Asia over the past 30 years (Figure 2). During this period more than one-third of all foreign students were from Asian countries. By 1985 students from these countries comprised over 40% of the total number of foreign students. Nearly one half of the foreign students enrolled in American Universities and Colleges in 1984 came from 10 countries.

Growth in number of Indian students in the US—1955–85

India is one of the ten leading countries of origin of foreign students enrolment in US institutions of higher

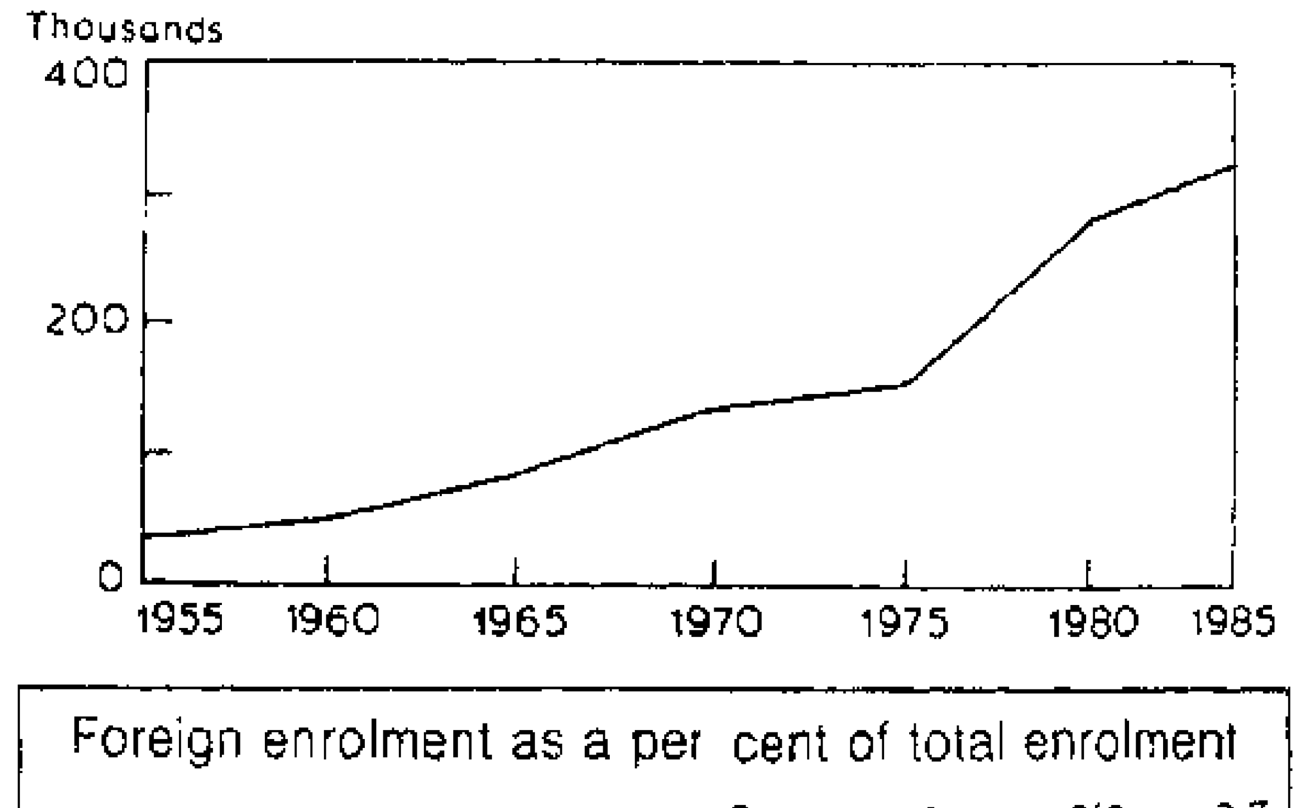

Figure 1. Total foreign student enrolment in US institutions of higher education: 1955–86.

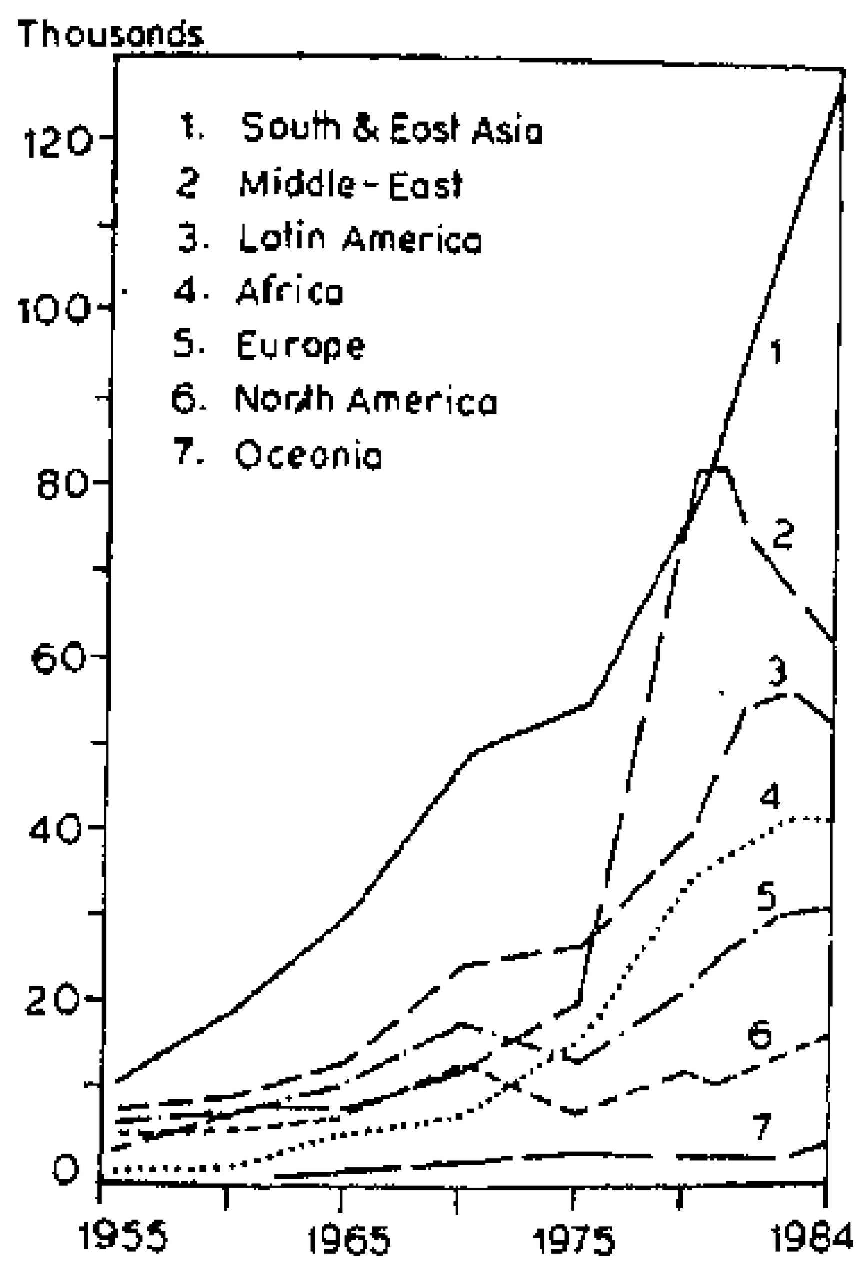

Figure 2. Foreign students enrolment in the US by region of origin.

education in 1955, 1980 and 1985. Table 3 shows that the number of Indian students in US institutions has increased nine times from 1955 to 1985.

Fields of study of Indian students in 1984

During 1984 there were 6205 Indian graduate students studying for their master's and doctorate degrees. Table 4 gives percentage distribution of their fields of study.

More than three-fourths of them were enrolled for S&T courses. About 40% were enrolled for engineering and technology.

Doctoral education in USA

US citizens, both native as also naturalized, have shown an increasing tendency to enter the labour market in that country before achieving a doctorate degree especially in engineering, because of higher starting salaries being offered to students with bachelor's and master's degrees. This enables many ambitious non-resident foreigners staying in USA to accept less lucrative jobs that allow them additional research, training as well as an opportunity to remain in that country for an extended period. Studies made by NSF show that non-US citizens having permanent visas that enable them to remain indefinitely in USA, if they so choose, enter the work force in US early in their academic career like other US citizens. As such most of the foreigners who go in for doctorate and higher education in USA are students with temporary visas.

For the reasons cited in the preceding paragraph, engineering colleges in USA are unable to attract adequate number of US citizens to their master's and doctoral programmes so they have to look increasingly to foreign-born nationals. These nationals are not only working as substitute for US students but generally as satisfactory substitutes. Since 1981 more than half of the engineering doctorates awarded in US have been to foreign citizens. They also earned nearly 20% of the science doctorates.

In some science fields especially mathematics and computer sciences nearly 1/3rd of the awards have been to foreigners.

The growing trends in foreign involvement in US science and engineering have raised many questions among public and private sector science and technology policy officials over the possible future impacts on US higher education and industry. Attempts are being made to maximize the participation of US citizens—men, women and minorities. Demographic projections attempted by the Bureau of Labour Statistics, USA, suggest a potential decline in the flow of US citizens into the scientists and engineers labour force. The effect of this would also be felt in higher education as also in employing organizations like government agencies carrying out R&D activities.

Table 3. Ten leading countries of origin in foreign student enrolment in US institutions of higher education: 1955, 1980 and 1985.

1955	Foreign enrolment	Percentage distribution	1980	Foreign enrolment	Percentage distribution	1985	Foreign enrolment	Percentage distribution
Leading 10 countries by rank	17,550	51.3	Leading 10 countries, by rank	157,130	54.9	Leading 10 countries, by rank	159,310	46.6
1. Canada	4,660	13.6	1. Iran	51,310	17.9	1. Taiwan	22,590	14.2
2. Taiwan	2,550	7.4	2. Taiwan	17,560	6.1	2. Malaysia	21,720	13.6
3. India	1,670	4.9	3. Nigeria	16,360	5.7	3. Nigeria	18,370	11.5
4. Japan	1,570	4.6	4. Canada	15,130	5.3	4. Iran	16,640	10.4
5. Philippines	1,480	4.3	5. Japan	12,260	4.3	5. Rep. of Korea	16,430	10.3
6. Colombia	1,300	3.8	6. Hong Kong	9,900	3.5	6. Canada	15,370	9.6
7. Mexico	1,250	3.7	7. Venezuela	9,860	3.4	7. India	14,610	9.2
8. Rep. of Korea	1,200	3.5	8. Saudi Arabia	9,540	3.3	8. Japan	13,160	8.3
9. Iran	1,000	2.9	9. India	8,760	3.1	9. Venezuela	10,290	6.4
10. Venezuela	830	2.6	10. Thailand	6,500	2.3	10. Hong Kong	10,130	6.4
Other countries.	16,680	43.7	All other countries	129,120	45.1	All other countries	182,803	53.4
Total	34,230	100.0	Total	286,300	100.0	Total	342,113	100.0

Conclusions

About 10,000–15,000 Indian students seek admission in US universities every year while the number of those who are admitted in institutions of higher education in India is 3.3 million. Despite the fact that the proportion of students proceeding to USA *vis-a-vis* those within the country is comparatively small, yet it includes the top 25–30% of the product of Indian Institutes of Technology who have been provided specialized training at a great cost to the exchequer. After acquiring higher degree, they prefer to work and stay abroad. This leads to the non-availability of highly skilled Indians for the jobs within the country. While it is not the only factor but probably one of the factors why, in large areas of economic activities, relatively obsolete cost ineffective technology exists, technological innovation remains unimpressive and adoption of scientific and technological knowledge is depressingly low even after 40 years of independence. While our own progress and technology remain stagnant, advanced countries of the West continue to utilize our talent both to their economic as also scientific advantage.

If the average expenditure on the education of an engineer in India is estimated at Rs 1.50 lakhs, the total loss to India over the last 20 years in respect of 21,000 Indian engineers settled in USA (Table 1) would roughly be of the order of 0.2 billion US dollars

$$\left(\frac{1.5\times 21\times 10^3\times 10^5}{1.3\times 10^1}=240 \text{ millions}=0.25 \text{ billion}\right).$$

Per year loss would be roughly 11 million US dollars $\left(\frac{1000\times 1.5\times 10^5}{1.3\times 10^1}=11 \text{ million}\right)$. The benefits that accrue to US would be of the order of 10–12 billion US dollars because of the high cost of education in that country. However, the real loss of human capital to India cannot be quantified so simply. It would be pertinent to refer to an UNCTAD study which had revealed that in 1970 US aid to less developed countries amounted to 3.1 billion US dollars. As against this the income of USA through the brain drain from less developed countries amounted to US $ 3.7 billion.

There is undoubtedly a need to expose our talented boys from IITs and other institutions to the advanced facilities in higher education and training available in US and other Western countries. The government might consider deputing a reasonable number of such students every year on scholarship basis for periods ranging from one to two years to these countries. Before they go they may be assured jobs in National Laboratories at wages commensurate with their education and training. In this connection it would be pertinent to refer to the new scheme for better opportunities for young scientists in chosen areas of Science and Technology (BOYSCAST) approved by the Government. The objectives of the scheme are:·

> Provide opportunities to young scientists for visiting international institutions to enable them to participate in and contribute to the latest developments in specially chosen frontline areas of science and technology through personal interaction with scientists and technologists abroad.
>
> Use the experience and talent of these young scientists and technologists to initiate and strengthen national programmes in these identified chosen areas (thrust areas) of science and technology.
>
> Use these talented young people to further generate and spread expertise at the national S & T institutions working in these chosen areas of Science and Technology.

The Indian and US governments have also recently introduced a Gandhi–Raegan fellowship scheme which will also help Indian scientists to gain research experience through their placement in major US institutions in selected areas.

No doubt the Government of India is quite alive to the situation and a number of measures have been taken to improve the working conditions of scientists and technologists but much more ought to be done to stem the tide of outflow of bright scientists and technologists from the country and to induce them in pursuing their interest within the country.

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Dietary and nutritional guidelines for food and agricultural planning

S. Varadarajan

INDIA has made remarkable progress in agriculture and food production in the last twenty-five years in moving towards a high degree of self-reliance in food in broad terms. Planning for food production must be related to plans to achieve balanced nutrition overall. It is therefore appropriate to examine nutritional requirements in some detail, review the extent to which these are being met, and to develop plans and strategies for rapid improvement in the nutritional status of our people.

It is hoped to virtually abolish poverty by the year 2000 and achieve to a high degree the Alma Ata declaration of Health for All by that year. India's agricultural output in 1988–89 represents a remarkable new peak, and has given greater confidence in aiming for a target of 240 million tonnes of cereals and pulses in ten years. The success in management of distribution of food supplies in the previous three years of drought is yet another base for reliable food availability at consumption points and augurs well for a policy for better nutrition.

Nutrition is the major component of human health and it is from a satisfactory nutritional status that many desirable objectives in quality of life can be achieved. Universal immunization and eradication of many communicable diseases should be accompanied by improved nutrition. The provision of safe potable drinking water has been stated to be an objective from the Second Plan. The mounting of a Technology Mission for provision of safe drinking water is a recognition of the importance of the problem and will enhance the value of nutritional interventions. The high rate, of over 100 per thousand, of infant mortality should be reduced to a level of 20 to 25 quickly. This will not only reduce sorrow, suffering and wastage of human resource but will also help to attain a sharp lowering of the rate of population growth from the present 2.1 per cent. Universal primary education and literacy among the young again depend on the attainment of good child health and nutrition. The Technology Mission on oilseeds and oils aims at self-reliance and reduction in imports but should contribute to improved nutrition, particularly of the poor sections. The Mission on telecommunications recognizes the significance of rural automatic exchanges; a good rural communication network and access to information will hopefully enhance the timely availability of essential nutrient and provide better returns for agriculture, primary food processing, preservation and marketing. The ratio of women to men in India is 929 to 1000. This results from higher infant mortality in females and, more particularly, from high mortality among young adult women, whose nutritional status steadily declines with birth of children and the stress of providing breast milk, and as a result of low food intake after meeting the needs of the growing family and the labour of gathering fuelwood and water. The stress results in high mortality of mothers at the birth of the second or a later child or from communicable diseases to which resistance is low because of poor nutrition. Several million children are thus brought up without the advantage of having the mother. The lower life expectancy for females in India, compared to that for males, merits serious study as this situation is contrary to that in developed countries.

The reports of the National Nutrition Monitoring Bureau (NNMB) of the Indian Council of Medical Research (ICMR), managed by the National Institute of Nutrition in Hyderabad, are now making available more detailed information on nutritional status and food intake. The studies on which the first reports are based provide data that show an improvement in calorie intake during the last ten years, but were limited to a few select areas in a small number of states. Calorie intake data are major basic parameters for determination of the extent of poverty and of nutritional status. It is of vital importance to national planning to substantially enlarge the investment and scope of NNMB by extending it to all states and to increase sampling and the amount of detail in the collection of information. The Recommended Dietary Allowances in India, last published in 1978, were revised recently by a committee constituted by ICMR. The new standards should form the guidelines for nutrition and dietary intake, and should help to plan agriculture and food production. There is recognition of new issues and opportunities in agricultural planning: evolution of strategies based on agroclimatic conditions; higher priority for minor irrigation, drainage and water management; increased role in quality seed production for both public and private sectors; special attention to dryland farming and drought-resistant crops; greater emphasis on oilseeds and pulses; and the need for better food storage and modern processing for efficiency and quality.

In the context of such favourable trends and improved information systems, the new knowledge on nutrition can be pointedly focused on planning for availability of nutrients at affordable costs. The projections for different categories of foods can now be outlined and a plan suggested. Cereal production, particularly of wheat and rice paddy, has dominated agricultural planning to the neglect, to an extent, of other food components. Costs of production have been sought to be minimized by special reduced rates for water for irrigation and electrical power and diesel for pumping of water, subsidies for fertilizers, as well as slow increases in procurement prices. Availability of certified quality seeds, integrated inputs and crop insurance have been some constraints. Prices of cereals have been maintained well but not of other items such as vegetable oils, pulses, sugar, vegetables, fruit, meat and fish. The price of milk has been sought to be controlled. Imports have been utilized for essential food products such as cereals, cooking oil and sugar. The objective should be to increase productivity per unit land area sharply to ensure adequate returns as well as lower prices. There are attempts to reduce subsidies to agriculture in western Europe and North America and to lower total production of cereals and dairy products. The Worldwatch Institute has estimated that world cereal food stocks are only for six weeks, an all time low. Indian cereal requirements are larger in comparison to tradeable surpluses. This is particularly so in the case of rice. World prices are bound to rise in the context of lower subsidies and production. It is therefore paramount that India achieves full food self-sufficiency and carries adequate stocks at all times since imports may not be feasible, even at high prices. Individual food item targets could be now examined for fullest self-sufficiency.

For this purpose the draft recommended that Dietary Allowances formulated in 1989 could form the basis. The average adult weight of man and woman has been increased by five kilos resulting in 60 and 55 kgs. respectively. The daily calorie intake allowance for an adult man with medium energy expenditure is estimated as 2400. Visible fat intake has been somewhat lowered and is recommended at 15 g daily.

The demand for major items of food is determined not only by actual need for consumption but also by prices, subsidies, purchasing power, generally unrestricted availability throughout the year at all locations and consumer preferences. Increasing nutritional quality, and absence of adverse components play a part in consumer preferences. Demand should be estimated in developing countries such as India on the basis of affordable prices.

Cereals and pulses

The demand for food in 2000 AD is estimated at 240 million tonnes by the Planning Commission. This is based on current consumptions and projected population growth. The Science Advisory Council to the Prime Minister estimates demand to be 300 million tonnes. If the population crosses one billion and poverty is to be virtually abolished, calorie sufficiency and elimination of hunger will have to be achieved, and agricultural production and food availability should be substantial. If two fifths of present population should receive 15% more food as calories then the current real demand would be higher by at least 6%. Some other sectors above poverty would also have an increased intake. The total real demand, with adequate purchasing power would be 200–210 million tonnes by 1990. The total demand may be 260 million tonnes in 2000 AD. Some allowance may be for storage, processing and distribution losses and for diversion to animal feed. Urbanization increases demand for milk, eggs and meat. The total could be 270 and 280 million tonnes assuming a population growth rate of 1.8 to 1.9%. The aim should be to produce 280 million tonnes in good monsoon years by 2000 AD and build up stocks of 30–35 million tonnes to meet shortfalls in drought years.

The major cereal demand is for rice. World tradeable surplus in rice is low, of the order of 6 to 10 million tonnes. Indian shortages cannot be met by imports in the case of rice. It is therefore essential to plan for substantial productivity increase in rice. At the same time, steps should be taken to popularize wheat as well as less popular cereals. There are high demands and shortages in USSR and Africa and Indian requirements for any imports have to compete with these countries. India has clearly the potential to produce 270 to 280 million tonnes in good monsoon year if the trend of improved productivity is extended to Eastern UP, Bihar, Madhya Pradesh and Orissa. These estimates also take into account some losses in increased urbanization and distribution. The real costs of production, eliminating subsidies in all countries, are still competitive in India. Surpluses of cereals can be exported if any such occur. Planning Commission ideally would wish to have a growth of 4% per annum in agriculture in the next ten years to markedly increase rural earnings and thereby contribute to national economic growth of 6 to 7% per year. Such an objective would also require a target of 270–280 million tonnes of food grains by 2000 AD.

A comparison with developed countries would further substantiate such targets. USSR with a population of about 240 million produces 220 million tonnes of food grains and requires 20 million tonnes to be imported. USA with a population of 230 million produces 250 million tonnes and has a surplus of 20–30 million tonnes to export. Indian population by 2000 AD will be four times larger than these countries at present and it is not unreasonable to aim at 270–280